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ABSTRACT

Described is a study to determine the degree of relationship between selected classroom and teacher variables and science teaching strategies. The perceived strategies were recorded and measured by the Class Activity Checklist (CAC) which is a modification of the Science Class Activities Checklist (SCAC), (Yeany, 1974). The observed teacher behavior was recorded through use of the Teaching Strategies Observation Differential (TSOD), (Anderson, 1974). Data tables and data analyses are presented. Conclusions drawn show a moderate correlation of the CAC and an instructor's years of teaching, indicating that younger teachers are perceived as being indirect in teaching style. Teachers in larger schools are also perceived as indirect by students. Correlations of the number of laboratory days to the CAC, and the number of options opened to students and the CAC, indicated that students were aware of activity options offered them. In the appendix a copy of the CAC checklist, a background questionnaire, a class composition questionnaire, and the TSOD are presented. (Author/EB)

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A STUDY OF THE RELATIONSHIPS BETWEEN PERCEIVED AND OBSERVED SCIENCE TEACHING STRATEGIES AND SELECTED CLASSROOM AND TEACHER VARIABLES

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INTRODUCTION

Statement of the Problem

The purpose of the study was to determine the degree of relationship between selected classroom and teacher variables and science teaching strategies as perceived by both instructors and students, and as observed by trained observers. The perceived strategies were recorded and measured by the Class Activities Checklist (CAC) (see Appendix) which is a modification of the Science Class Activities Checklist (SCAC) (Yeany, 1974). The observed teacher behavior was recorded through the use of the Teaching Strategies Observation Differential (TSOD) (Anderson et. al. 1974) (see Appendix).

Hypotheses

The following statistical hypotheses were tested:

I. There is no significant relationship between the observed teaching strategies of a science teacher as measured by the TSOD and the following variables:

1. The sex of the teacher
2. Years of teaching experience
3. Level of education of the teacher
   a. Undergraduate hours in science
   b. Graduate hours in science
4. The number of laboratory days per week
5. The number of lecture days per week
6. The number of activity options given to students

7. The size of the school

8. The ability level of the class as perceived by the teacher

9. The ability level of the class as indicated by IQ measures

II. There is no significant relationship between the teachers' strategies as perceived by students and measured by the CAC and the following variables:

1. The sex of the teacher

2. Years of teaching experience

3. Level of education of the teacher

   a. Undergraduate hours in science

   b. Graduate hours in science

4. The number of laboratory days per week

5. The number of lecture days per week

6. The number of activity options given to students

7. The size of the school

8. The ability level of the class as percieved by the teacher

9. The ability level of the class as indicated by IQ measures

III. There is no significant relationship between the students' perception of teaching strategy as measured by the CAC and the observed teaching behavior as measured by the TSOD.

Delimitations

The research design called for a correlational analysis of the problem and not experimental manipulations. Assessment and consequent modification of any given teaching style was left to the individuals to actualize based on feed-back from this study. No follow-up was planned.

PROCEDURE

Sampling Method

The 1973-74 Directory of Illinois Public Schools was used to compile a list of names and addresses of Southern Illinois public schools. The cooperation of a minimum of thirty instructors with an average of three classes each was required to establish statistical power and increase the generalizability of the study. Forty-two teachers in eight schools were eventually involved. Each teacher agreed to an average of three class observations each. This was to insure a highly representative sample of individual teaching repertoire and a composite overview of Southern Illinois science teaching strategies. No attempt was made to alter the environments of respective classrooms, schedule arrangements, or teaching methods. A representative sample of a range of comparatively high, medium, and low ability classes as identified by the teacher was sought, and an assumption is made that instructors complied with this request.

Data Collection

Each class session observed was represented by a TSOD score, a Class Composition Questionnaire (see Appendix), and a consensus of five activities checklists (CAC) secured from students randomly selected from the teacher's roll book. An Instructor Questionnaire (see Appendix) was completed by each teacher to acquire instructor background information (i.e., sex, experience, perception of teaching style, and a record of professional training). The Class Composition Questionnaire identified for each class: (a) the instructor's perception of his use of a

given teaching technique employed for the class, (b) perceived class ability level indices, and (c) actual IQ scores of four randomly selected students.

To insure consistency in the use of the TSOD, the raters were trained by a person who was well versed in the utility of the instrument. This training involved the interpretation of the meaning and application of the TSOD in discussion and video-taped practice sessions. A high degree of reliability resulted from the sessions as evidenced by a Hoyt Coefficient value of 98.5 which increased from an original value of 58.3 in the first practice sessions.

The study schools were visited and data collected during April and May. Observations were made of class periods with TSOD tallies at one-minute intervals. Checklists required an average of six minutes to complete either before the session or at its completion following a short explanation of procedure. Follow-up visits or other arrangements convenient to the instructors were necessary to secure either checklists or observations not acquired in previous visits.

Responses on the CAC were assigned a numerical rank value agreed to by a panel of fellow science teachers. This value was based on the amount of directness or indirectness represented by the item. The checklists were machine processed, and a consensus of student perceptions of a teacher's strategy was represented by the mean score based on the individual students' responses.

The processing of the CAC was accomplished through the Mermac Test Analysis and Questionnaire package (Bussell, 1971). Table 1 illustrates weights designated for each response.

TABLE 1

WEIGHTS ASSIGNED TO RESPONSES ON THE CAC

Direct Teaching Behaviors	Response	Indirect Teaching Behaviors
1	Always	5
2	Frequently	4
3	Sometimes	3
4	Rarely	2
5	Never	1

Data Analyses

The data were analyzed by an IBM 370 computer using the Bio-Medical Computer Program #BMD02D (Dixon, 1970). The program computed correlation coefficients, means, and measures of dispersion on variables entered or a transgeneration of variables entered to create new variable combinations. In addition, it yielded cross-tallied plots of two selected variables for visual inspection of correlational agreement.

The Hoyt inter-rater and intra-rater reliability were calculated through the BMD02V program (Dixon, 1970).

An attempt was made to increase the power of the study by relaxing the alpha level to the .10. Although this would increase the risk of committing a type I error, this decision would enable the researchers to identify significant relationships and reduce the risk of commiting a type II error; therefore, the first reference on all r values was made at the alpha = .10 level.

RESULTS

Testing of Hypothesis I showed that variable number 3, the number of course credit hours of the graduate level (with $r = .178$) ($p < .05$) and variable number 5 the number of lecture days per week (with $r = .194$) ($p < .05$) were significantly related to teaching strategy as measured by the TSOD (Table 2).

When the number of course credit hours taken at the graduate level was broken down into specific subject areas (e.g., biology, physics, chemistry), the number of graduate biology courses taken (with $r = .192$) ($p < .05$) and the number of physics courses taken (with $r = .208$) ($p < .05$) correlated significantly with the TSOD variables. All other hypotheses tested remain tenable as no evidence supports their rejection at the .10 level (Table 3).

A test of Hypothesis II reveals that a number of sub-hypotheses are rejected as follows: First variable 2, the years of teaching experience in relation to the CAC measure (with an $r = -.373$) ($p < .01$) showed a significant relationship. A moderate negative relationship then exists. Second, variable 3, the total number of graduate course credit hours taken (with an $r = .029$) ($p > .10$) and $r = .0003$ ($p > .10$) for the undergraduate level evidences no sifnificant relationship with the CAC (Table 4).

However, when the number of course credit hours were broken down into specific subject areas, earth science and "other" science courses with ($r = -.255$) ($p < .01$) and ($r = .169$) ($p < .10$) respectively indicate significant relationship with the CAC. (Especially earth science with

TABLE 2

CORRELATIONAL VALUES FOR THE TSOD AGAINST SELECTED VARIABLES

Variable	
Sex	-.0389
Service	.1046
Total Number of Hours in a Given Discipline:	
A. At Graduate Level	-.0945
B. At Undergraduate Level	-.1779*
Lab Usage per week	.1083
Lecture Usage per week	.1942*
Learning Opportunities	.1505
School Size	.0099
Perceived IQ	-.0323
Actual IQ	.1199

Critical values of correlations at 112 degrees of freedom are:

r at .10 = .164
r at .05 = .195
r at .01 = .254

TABLE 3

CORRELATIONS BETWEEN THE TSOD SCORES AND
THE NUMBER OF COURSES TAKEN IN EACH SCIENCE DISCIPLINE

Discipline	Graduate	Undergraduate
Biology	.1920 *	-.1415
Chemistry	.0371	-.1073
Physics	.2081 **	-.0092
Earth Science	-.0378	-.1068
Other	.0526	-.0553

Critical values of correlations at 112 degrees of freedom are:

r at .10 = .164
r at .05 = .195
r at .01 = .254

TABLE 4

CORRELATIONAL VALUES FOR THE CAC AGAINST SELECTED VARIABLES

Variable	
Sex	.0153
Service	-.3733***
Total Number of Hours in a Given Discipline:	
A. At Graduate Level	.0292
B. At Undergraduate Level	.0003
Lab Usage per week	.3973***
Lecture Usage per week	.2505**
Learning Opportunities	.4096***
School Size	.3068***
Perceived IQ	.0462
Actual IQ	.0705

Critical values of correlations at 112 degrees of freedom are:

r at .10 = .164
r at .05 = .195
r at .01 = .254

a significant negative correlation) (Table 5). Third, the number of laboratory days per week, variable 4 (with $r = .397$) ($p < .01$) indicates a moderate correlation with the CAC. Fourth, variable 5 the number of lecture days per week (with $r = .251$) ($p < .05$) is also significantly related to a teaching behavior measured by the CAC (Table 4).

Fifth, the number of activity options given to students, variable 6 (with $r = .410$) ($p < .01$) indicates that a moderate relationship exists when correlated with the CAC. Finally, variable 7, the size of the school in relation to the CAC measure (with $r = .307$) ($p < .01$) similarly indicates a moderate correlation (Table 4).

Analyses of variables 1, 3, 8, and 9, the number of credit hours accumulated by the teacher, against the CAC, the teacher's perceived ability level of the class against the CAC, and finally, the actual ability level of the class against the CAC show low correlation values, and support the null hypotheses (Table 4).

Hypothesis III, there is no significant relationship between the students' perception of teaching strategy as measured by the CAC and the observed teaching behavior as measured by the TSOD (with $r = .060$) ($p > .10$) also remains tenable (Table 6).

CONCLUSIONS

A moderate correlation of the CAC and an instructor's years of teaching shows that younger teachers are perceived as being indirect in teaching style. Younger teachers may have adopted more of the

TABLE 5

CORRELATIONS BETWEEN THE CAC SCORES AND
THE NUMBER OF COURSES TAKEN IN EACH SCIENCE DISCIPLINE

Discipline	Graduate	Undergraduate
Biology	.0067	-.0611
Chemistry	.1016	.0753
Physics	-.1062	.0173
Earth Science	-.2552 **	-.1581
Other	.1686 *	.1096

Critical values of correlations at 112 degrees of freedom are:

r at .10 = .164
r at .05 = .195
r at .01 = .254

TABLE 6

CORRELATIONAL VALUES FOR THE CAC AGAINST THE TSOD

	Level of Significance
.0598	

Critical values of correlations at 112 degrees of freedom are:

r at .10 = .164
r at .05 = .195
r at .01 = .254

current innovations or have had recent exposure to courses emphasizing new practices. On the other hand, the more senior teacher may be more content with a more traditional teaching strategy and/or no longer enrolls in courses and workshops stressing a variety of teaching strategies.

Teachers of larger schools are also perceived as indirect by students while those in smaller schools are viewed as direct in style. One explanation might be the influence of a number of colleagues in larger schools. Another might be the demographic influence of a more metropolitan sophistication. Further, one might conclude that a smaller school has fewer staff replacements over time and is thus less altered due to homogeneity of the staff. Finally, larger schools may have better facilities (e.g., well equipped laboratories) where teachers may provide activities that would make them appear more indirect.

A correlation of the number of laboratory days to the CAC, and the number of options open to students and the CAC indicates that students are aware of activity options offered them. Additionally, the laboratory is seen as a well recognized activity in science classes overall. These findings verify the teacher's statements in the questionnaire that these options exist for the students.

However, there is a low positive relationship between the CAC and the number of lecture days per week. Although students perceived teachers as being indirect, teachers are employing the lecture method. Perhaps teachers are including some form of student input such as a lecture-discussion or a question-answer session. On the other hand,

the students might deem a highly structured sequence necessary for them, and at the same time recognize to a greater extent than teachers, the actual avenues or options open to them.

A collective examination of the CAC scores reveals that with a mean score of 3.22 (where 1 is extremely direct and 5 is extremely indirect) that the majority of teachers surveyed and observed are perceived as more indirect in style by their students. A test of inter-rater reliability among students indicated a Hoyt reliability of .83 for student ratings on the CAC. Apparently students are viewing their teachers as teachers view their own performance. Further, that students are a reliable source of information regarding classroom activity is a supported premise.

An examination of TSOD scores and the number of graduate hours especially in biology and physics indicates that the teachers who receive more training are more indirect from an observational standpoint. Again, it is assumed that as teachers are exposed to current techniques, they begin to employ these techniques in their teaching (the study was not experimental and therefore, the directional of this causation might freely be questioned).

A low positive correlation of the TSOD with the amount of lecture employed (number of lecture days per week) verifies teacher's reports that they use the lecture method.

An examination of the means and standard deviations on the classroom variables is shown as Table 7. Many descriptive conclusions can be drawn by inspecting this data.

TABLE 7

MEANS AND STANDARD DEVIATIONS OF
SELECTED SCIENCE CLASSROOM VARIABLES

Variable	$\bar{X}$	S.D.
1. TSOD	3.9	1.0
2. CAC	3.2	.23
3. Years service	11.4	8.5
4. Total graduate hours	42.0	29.2
a. Biology	9.9	17.6
b. Chemistry	4.0	9.6
c. Physics	2.2	5.5
d. Earth Science	.4	.52
5. Total undergraduate hours	82.9	34.32
a. Biology	27.8	21.6
b. Chemistry	13.8	13.7
c. Physics	6.6	7.8
d. Earth Science	4.4	7.2
6. Use of lecture	3.5	1.2
7. Learning options	3.8	1.2
8. Lab use	1.9	1.5
9. Estimated IQ	105.3	10.6
10. Measured IQ	106.5	9.5
11. School size	837.0	474.0

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APPENDIX

CAC CLASS ACTIVITIES CHECKLIST

This is a list of sentences about activities that might occur in your classroom. The list is designed to record activities that occurred as you remember them. Read each sentence and mark the corresponding numbered item on the answer sheet as a, b, c, d, e depending upon your choice for the item. An example is provided below for you.

EXAMPLE

37 Our teacher offers us free time to finish our homework at the end of our lesson.

Where: Always A Frequently B Sometimes C Rarely D Never E

---

1. In our science class we listen to our teacher tell us about science.
2. Our science teacher asks us to explain the meaning of things from our science book.
3. If we have an argument about something in science, the teacher tells us what is right.
4. Our teacher admits his/her mistakes.
5. My teacher repeats almost exactly what our science book says.
6. My teacher asks questions that make us think about things that we have learned.
7. My teacher asks us to think of ways to solve a problem.
8. My job is to copy down and memorize what the teacher tells us.
9. We are allowed time in class to talk with each other about science ideas.
10. Experiments are done by us rather than by the teacher.
11. Our work is to make drawings and label the parts.
12. If I do not agree with what my teacher says, he/she wants me to say so.
13. Most of the questions that we are asked in class are to clear up what the teacher or science book tell us.
14. We have science activities where we discover things for ourselves.
15. We are expected to learn most the details that are written in our science book.

Where: Always A | Frequently B | Sometimes C | Rarely D | Never E

16. We are asked to write out the meanings of lists of words.

17. I am not afraid to ask questions during science class. (I am encouraged rather than discouraged to seek the answer to a problem.)

18. We are asked to outline parts of our science book.

19. Our teacher asks us to figure out answers to new problems.

20. We are asked to think of reasons for what happens in our science experiments.

21. My teacher tells us how to do all of a science experiment.

22. When we talk about science, the students talk as much as the teacher.

23. We have science activities. i.e. Laboratory days, Nature Walks, etc.

24. We use an experiment to study a problem that comes up in science.

25. Our work in science is learning the names of things.

26. We can read our science book to find the answer to an experiment before we start.

27. Our experiments are done by someone while the class watches.

28. The science information I collect is not the same as someone else finds.

29. We spend our time in science doing experiments.

30. My teacher answers our questions by asking us questions to see ifwe can figure out the answer for ourselves.

31. We are allowed to do the experiments our own way.

32. Our teacher grades our science papers for neatness.

33. We talked about what happened in our experiments.

34. We spend a lot of time answering questions from the science book.

Code: Instructor #_____
School #_____
Class #_____

INSTRUCTOR: BACKGROUND INFORMATION QUESTIONNAIRE

Instructions:

Please read the following questions through carefully before attempting to answer them. Indicate your responses by the method described for each category. Make responses legibly in the spaces provided. Respond to all items, and once per item, to insure validity.

Place an "x" in the space provided.

1. The sex of the person surveyed is:

   a. Male _____
   b. Female_____

Fill in the necessary information. Specify in semester hours. (One quarter hour = 2/3 semester hour.)

2. The number of years you have taught professionally is _____.

3. The total number of graduate hours you have completed to date is _____.

4. The total number of graduate hours you have completed in science is _____.

   a. Biology _____
   b. Chemistry _____
   c. Physics _____
   d. Earth Science _____
   e. Other (specify) _____

   TOTAL _____

5. The total number of undergraduate hours you have completed in science is _____.

   a. Biology _____
   b. Chemistry _____
   c. Physics _____
   d. Earth Science _____
   e. Other (Specify) _____

   TOTAL _____

Code: Instructor #_____
Class #_____
School #_____

CLASS COMPOSITION QUESTIONNAIRE

Instructions:

Please read the following question through carefully before attempting to answer them. Indicate your response by the method described for each category. Make responses legibly in the spaces provided. Respond to all items and once per item, to insure validity. Fill out one questionnaire per science class.

1. Pertaining to this class, the area of study (subject) is _____.

2. This class meets during the _____ period.

3. I use the lecture method in presenting my materials:

   a. Always
   b. Very often
   c. Often
   d. Sometimes
   e. Seldom
   f. Never

4. I allow students to be responsible for their own learning experiences:

   a. Always
   b. Very often
   c. Often
   d. Sometimes
   e. Seldom
   f. Never

Fill in the necessary information. (Respond with a number.)

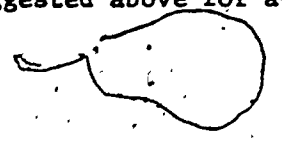
5. In a given week, I use the laboratory method on the average of _____ times.

For item #6 do not refer to guidance data or other sources.

6. I estimate the average IQ for this class to be approximately _____.

From the Guidance Department obtain the following data: From a list of students' names (in alphabetical order) select the first & last boy's and the first & last girl's name on the list. Average the two scores obtained for boys and for girls and record as a class average in the space provided.

7. The class average obtained by the method suggested above for average class IQ is _____.



8. The average (mean) male IQ is _____.

9. The average (mean) female IQ is _____.

10. The name of the IQ test administered in your school is _____.

Remember to fill out one questionnaire per class and to designate the area of study (subject), i.e. physics, chemistry, etc.

Teaching Strategy Observation Differential TSOD

I. NON-EDUCATIONAL ACTIVITIES

0_1 Non-educational activities beyond the teachers control.

This category includes class interruptions, such as announcements on the intercom, which are not under the control of the teacher. This zero rating is not averaged into the overall rating.

0_2 Teacher controllable non-educational activities.

This category includes managerial tasks (e.g., taking role), off-subject discourse and other activities which the observer judges to be "non-educational" but are normally expected to be susceptible to teacher influence.

II. DIRECT VERBAL

In this category the students are either passive or at most responding only in a limited verbal way to teacher stimuli.

1. Facts: e.g., direct exposition of content as in lectures by the teachers. Students are involved only as listeners.

2. Direction or opinion: e.g., direct instruction on "how to" or direct influence on class activities through stated opinions. The students are involved only as listeners but the teacher's talk is presumed to be a prelude to student activity.

3. Limiting questions: questions structured for a definite answer, or for which only the "correct" answer is accepted. Student involvement is limited to one word or phrase response to teacher questions.

III. DIRECT NON-VERBAL

In this category, student activity is heavily teacher dominated but includes non-verbal activity as well as verbal.

4. Demonstration: direct instruction using equipment, books, chalkboard, etc., either before the whole class or in a manner as would affect most of the class, e.g., showing several individuals or small groups "how a reaction must be obtained." The students role is that of observer as well as listener but interaction with the teacher is limited to simple clarification of teacher verbalization.

5. Student exercises: students are following the directions of a recipe (presented either orally or in visual form) in working with materials such as laboratory equipment, maps or tools. The student's activities are determined by the teacher in a manner that results in students' thought and actions being directed toward pre-specified or "correct" results.

IV. INDIRECT VERBAL

This category is characterized by verbal interaction between teacher and students, and between students and students, which goes beyond simple and limited response to teacher stimuli. The students' verbalization influences the pattern of the interaction.

6. Teacher questions: questions of an open ended nature which are probing and necessitate individual student thought and for which variations in response are accepted. Students play a major role in determining the pattern of the verbal interaction.

7. Teacher response: teacher is responding to student questions or comments. The response may or may not be demanded by the student verbalization and it may itself be a question, but it is in direct response to student's questions or comments.

8. Teacher guidance: teacher guidance of inter-student discussion, planning, or presentation to stimulate and keep it thought provoking and to avoid shallowness and tengential trivia. The interaction is largely between students and the teacher serves only in the role of moderator or consultant.

V. INDIRECT NON-VERBAL

This category is characterized by student work that is not limited to verbal activity, but includes work with materials. In addition, the activity is not teacher dominated but gives the student varying degrees of autonomy.

9. Teacher planned investigation: student investigations in which the problems pursued are determined by the teacher, laboratory manual or guide rather than by the student. Outcomes, however, are not prespecified, i.e., no specific "recipe" is followed and all students do not necessarily follow the same routine.

10. Student planned investigations: student investigations in which the student participates in determining the specific problem he will pursue. The investigation is student planned and conducted and the teacher's guidance is limited to monitoring, encouragement and reference help.

Teaching Strategies Observation Differential (Form E)

Interval	Doodle Space	Rating
1		0 1 0 2 1 2 3 4 5 6 7 8 9 10
2		0 1 0 2 1 2 3 4 5 6 7 8 9 10
3		0 1 0 2 1 2 3 4 5 6 7 8 9 10
4		0 1 0 2 1 2 3 4 5 6 7 8 9 10
5		0 1 0 2 1 2 3 4 5 6 7 8 9 10
6		0 1 0 2 1 2 3 4 5 6 7 8 9 10
7		0 1 0 2 1 2 3 4 5 6 7 8 9 10
8		0 1 0 2 1 2 3 4 5 6 7 8 9 10
9		0 1 0 2 1 2 3 4 5 6 7 8 9 10
10		0 1 0 2 1 2 3 4 5 6 7 8 9 10
11		0 1 0 2 1 2 3 4 5 6 7 8 9 10
12		0 1 0 2 1 2 3 4 5 6 7 8 9 10
13		0 1 0 2 1 2 3 4 5 6 7 8 9 10
14		0 1 0 2 1 2 3 4 5 6 7 8 9 10
15		0 1 0 2 1 2 3 4 5 6 7 8 9 10
16		0 1 0 2 1 2 3 4 5 6 7 8 9 10
17		0 1 0 2 1 2 3 4 5 6 7 8 9 10
18		0 1 0 2 1 2 3 4 5 6 7 8 9 10
19		0 1 0 2 1 2 3 4 5 6 7 8 9 10
20		0 1 0 2 1 2 3 4 5 6 7 8 9 10
21		0 1 0 2 1 2 3 4 5 6 7 8 9 10
22		0 1 0 2 1 2 3 4 5 6 7 8 9 10
23		0 1 0 2 1 2 3 4 5 6 7 8 9 10
24		0 1 0 2 1 2 3 4 5 6 7 8 9 10
25		0 1 0 2 1 2 3 4 5 6 7 8 9 10
26		0 1 0 2 1 2 3 4 5 6 7 8 9 10
27		0 1 0 2 1 2 3 4 5 6 7 8 9 10
28		0 1 0 2 1 2 3 4 5 6 7 8 9 10
29		0 1 0 2 1 2 3 4 5 6 7 8 9 10
30		0 1 0 2 1 2 3 4 5 6 7 8 9 10

Subtotal _____

Rater _____ Teacher _____ School _____

Date _____ Average Rating _____